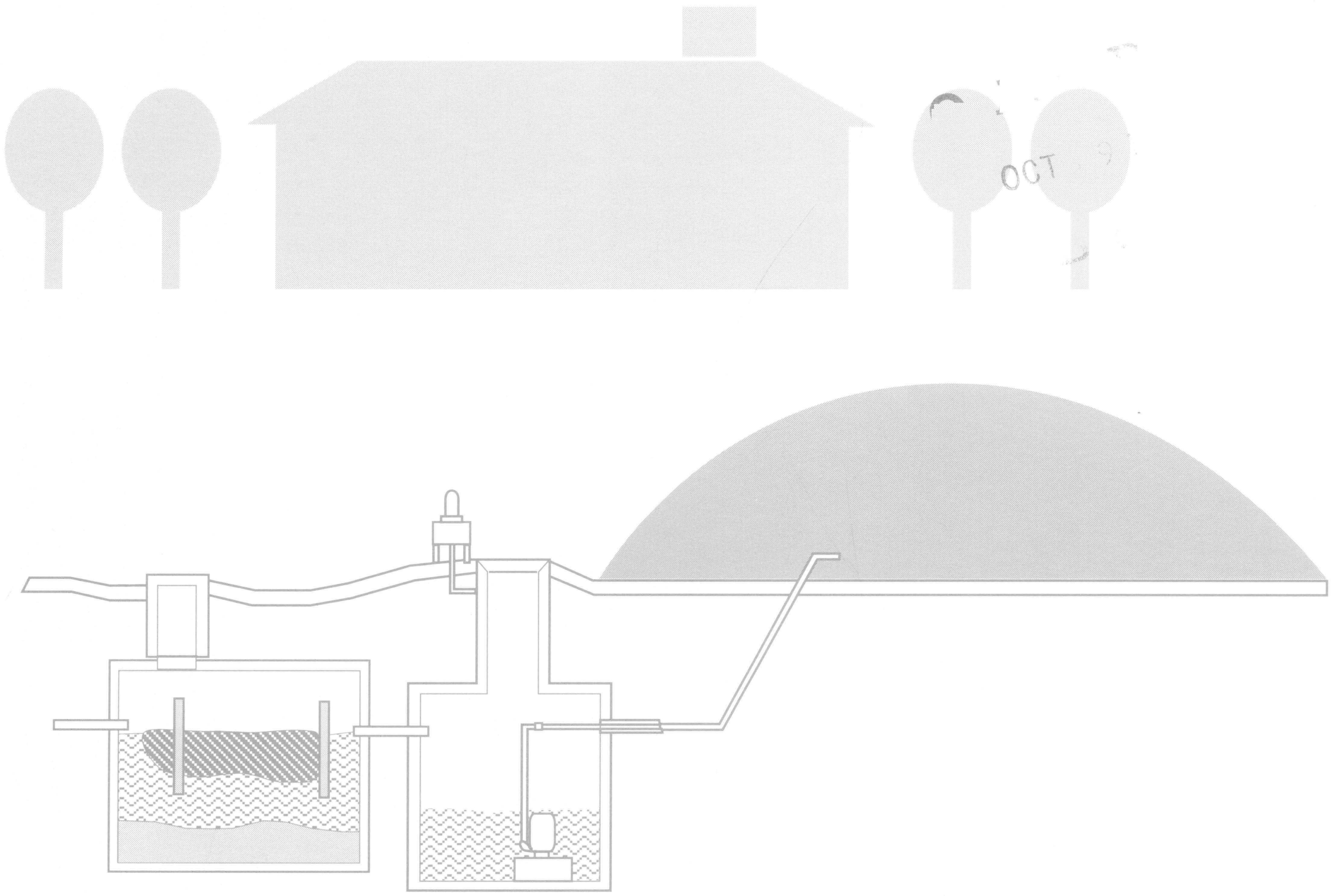
Bulletin 829

Mound Systems:

Pressure Distribution of Wastewater

Design and Construction in Ohio



THE OHIO STATE UNIVERSITY

Mound Systems:

Pressure Distribution of Wastewater

Design and Construction in Ohio

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The mound system is a soil absorption system constructed above grade that uses sand fill to enhance septic tank effluent treatment before the wastewater enters the natural soil at the site. Sites that may be unsuitable for a conventional subsurface soil absorption system may be suitable for a mound system.

The main components of a mound system are a septic tank for solids settling and storage, a dosing chamber to collect and pump the septic tank effluent and the mound for treatment of the septic tank effluent. Figure 1 illustrates the system components.

Detailed information on mound systems is presented in Bulletin 813, *Mound Systems for On-site Wastewater Treatment: Siting, Design, and Construction in Ohio*. Copies of Bulletin 813 are available through Ohio county Extension offices.

This bulletin examines the dosing chamber and distribution system that convey the septic tank effluent into the mound for treatment and disposal. The discussions on design and construction are intended to enable health officials and contractors to design, construct and inspect pressure distribution systems for mounds.

Uniform Distribution

Septic tank effluent is distributed in the mound through a series of perforated pipes buried in a layer of gravel above the sand fill (Figure 2). Uniform or even distribution of the septic tank effluent is especially important in mound systems. Uneven distribution of septic tank effluent can result in localized overloading and short-circuiting through the mound. Surface seepage in one area of a mound, as shown in Figure 3, may be caused by uneven distribution.

Uniform distribution is achieved using a pressure distribution system. Pressure distribution systems are carefully designed so that the volume of septic tank effluent flowing out of each hole of the distribution pipe is nearly identical. The pipe diameters and hole diameters must be carefully sized to achieve uniform distribution. A pump placed in a dosing tank is used to deliver the septic tank effluent into the mound and pressurize the system. Pressure distribution systems for mounds consist of five components:

1) lateral pipes with equally spaced holes drilled into the invert of the pipe;
2) manifold and main connected to the laterals;
3) dosing tank to collect septic tank effluent to be pumped to the mound,
4) pump to pressurize the system,
5) controls and power supply to operate the pump.

The steps to design and construct the five components of a pressure distribution system will be presented in this bulletin. To illustrate the steps, an example pressure distribution system for a mound will be presented in the series of figures, calculations and tables that follow this introduction. A green summary table across the bottom of the pages will help illustrate the steps for the example.

The steps presented herein can be used to design pressure distribution systems where each lateral is at the same elevation. Developing a pressure distribution system for a

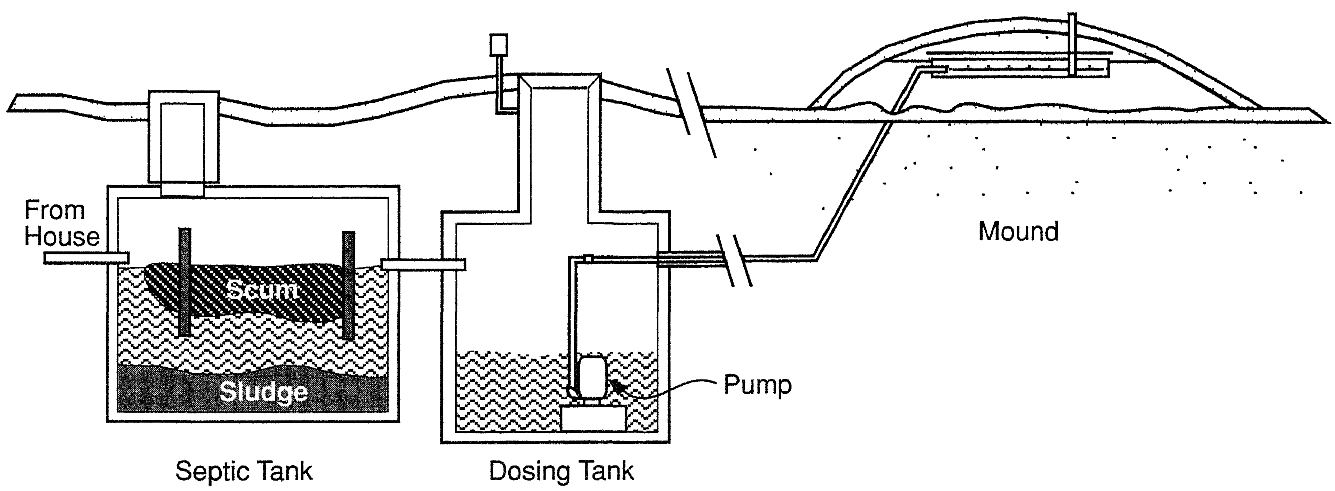


Figure 1. Mound system components. (after: Converse and Tyler. 1990)

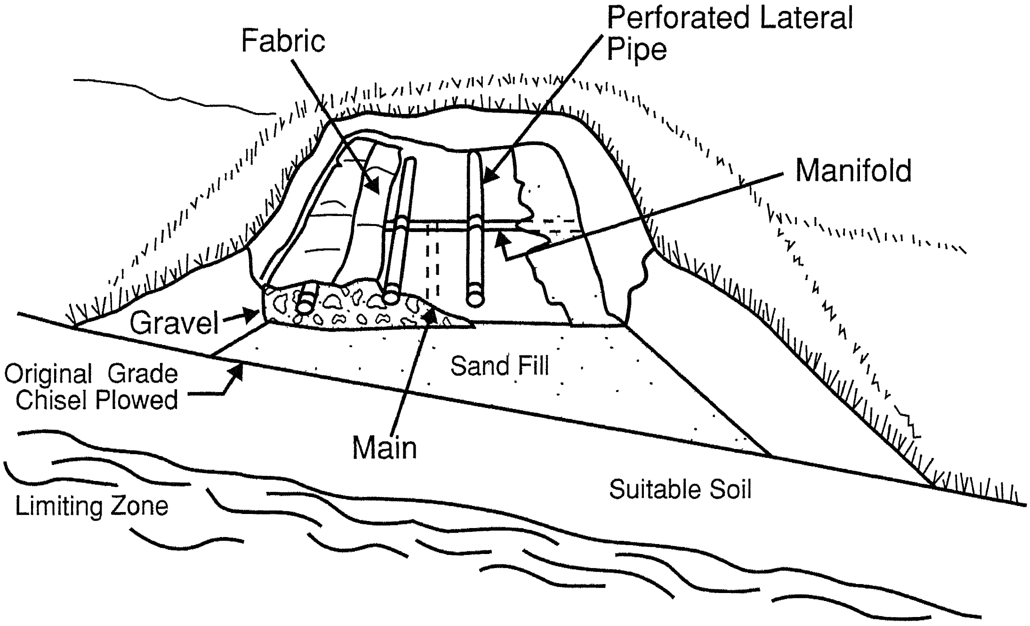


Figure 2. Mound distribution system.

series of laterals at different elevations is a little more involved and is not presented in this bulletin.

Lateral Pipes

In a pressure distribution system, small-diameter pipes are used to distribute the wastewater. The 4-inch perforated pipe used in conventional soil absorption systems is **not suitable** because it is too large and the holes are not appropriately sized and spaced to provide even effluent distribution.

Schedule 40 PVC pipe and fittings are typically used in pressure distribution systems. Holes are drilled perpendicular to the pipe in a straight line along the pipe invert (underside). Any burrs or rough edges must be removed from the holes so they do not collect debris and clog. Sliding a rod or small-diameter pipe along the inside of the lateral pipe works to remove burrs present on the inside of the pipe. Upon installation, the pipe must be clean and clear of debris and PVC cuttings that can clog holes. During construction, protect the ends of pipe to keep rodents and their food and nesting material out of pipes.

The pipe diameter, hole diameter and hole spacing are determined for each pressure distribution system. The sizing of the distribution pipe network is presented in the next five steps along with an example.

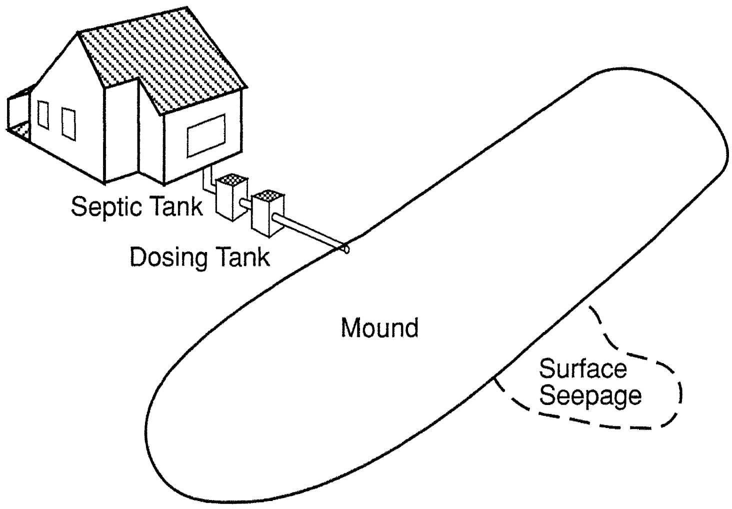


Figure 3. Indication of distribution failure: surface seepage at one portion of the mound. Inspection would show that other portions of mound are dry and not receiving effluent.

Step 1

Establish dimensions of mound from estimated daily flow rate and soil conditions (Figures 4 & 5) as described in Ohio Extension Bulletin 813, *Mound Systems for On-site Wastewater Treatment: Siting, Design, and Construction in Ohio*. Copies of Bulletin 813 are available from Ohio county Extension offices.

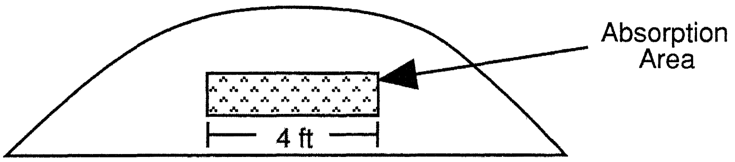


Figure 4. Side view of absorption area for mound system.

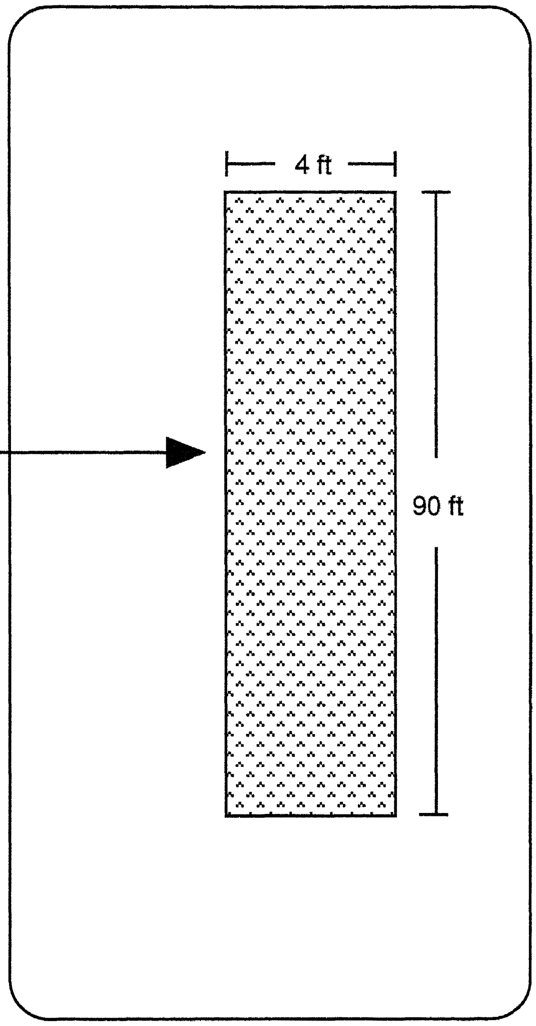


Figure 5. Top view of absorption area for mound system.

(1)	(2)
Field Width	Field Length
—	—
4 ft	90 ft

Step 2

Determine length of laterals and distance between laterals (Figure 6). Remember: All lateral lines are to be on the same elevation (Figure 7). The lateral length is measured from the distribution manifold to the end of the lateral. A center manifold is preferred because it minimizes pipe sizes. Figure 8 illustrates some possible manifold positions.

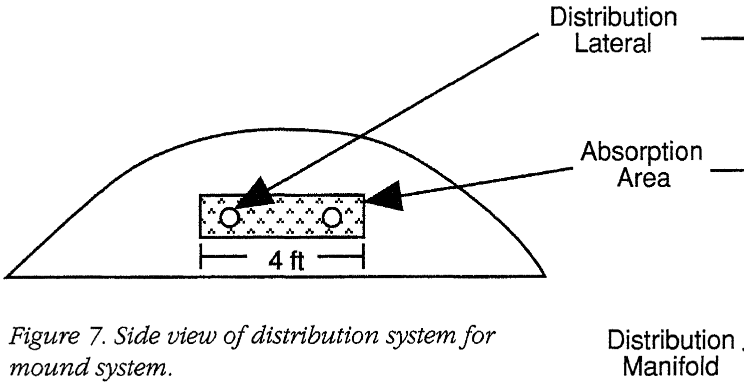


Figure 7. Side view of distribution system for mound system.

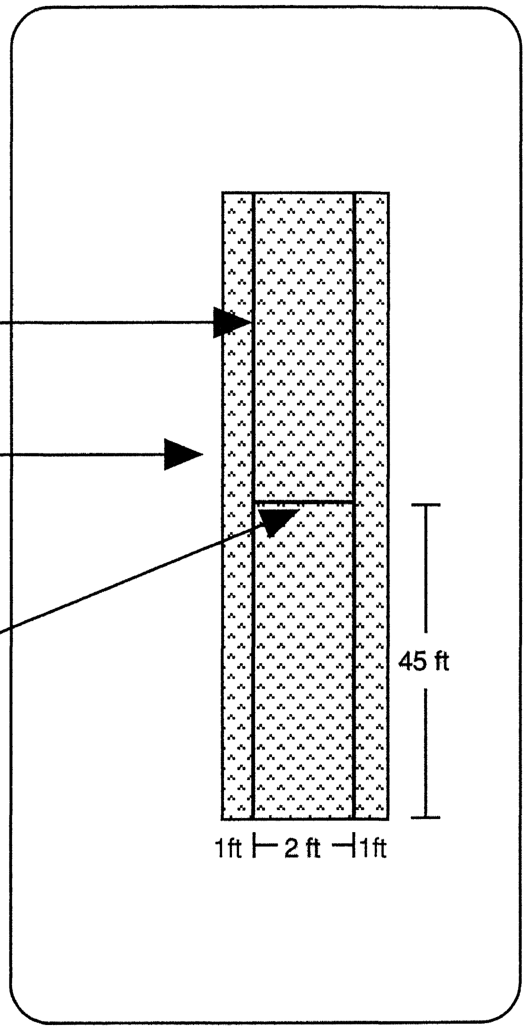


Figure 6. Top view of distribution system for mound system

(3)	(4)	(5)
Lateral Length	Lateral Spacing	Number of Laterals
—	—	—
45 ft	2 ft	4

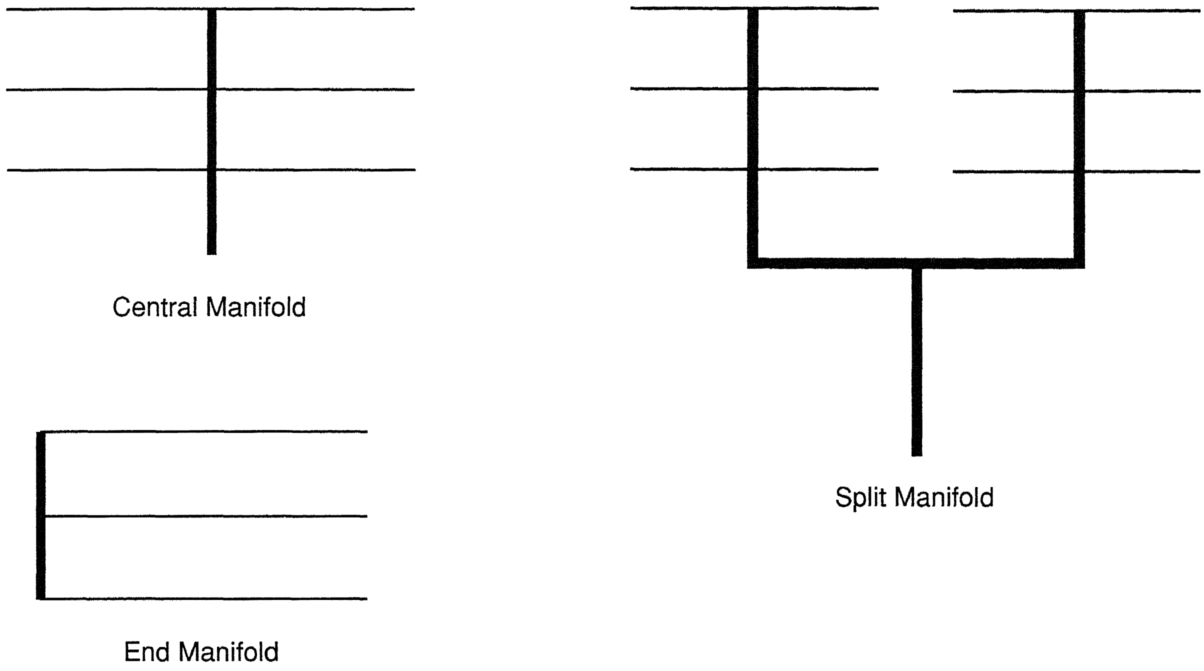


Figure 8. Alternative manifold positions for distribution systems.

Step 3

Determine hole spacing, which should be less than 5 feet. The higher the hole density, the more uniformly the wastewater is distributed. The holes should be staggered between adjacent laterals, if possible (Figure 9). A hole should always be drilled horizontally into the end cap near the crown of the pipe to facilitate venting as the pipe fills (Figure 10).

Select hole diameter. For systems serving single-family homes, ¼-inch holes are sufficient. Larger holes require larger pipe diameters and pumps. Smaller holes may clog.

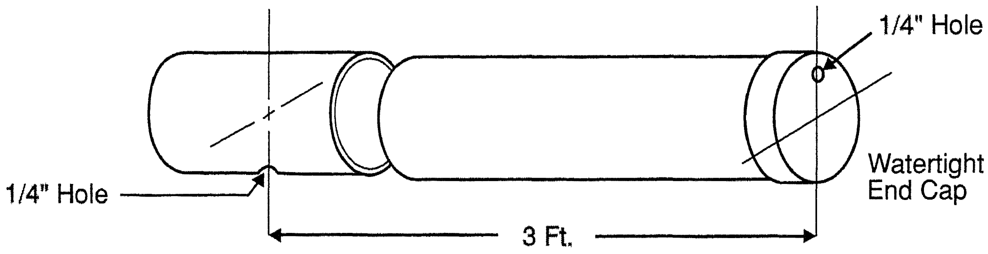


Figure 10. Side view of hole spacing in lateral of the distribution system.

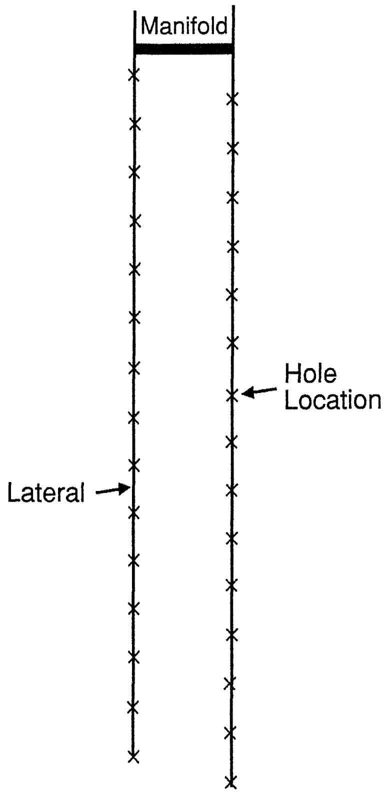


Figure 9. Top view of hole spacing in distribution system.

(6)	(7)	(8)
Hole Spacing	Number of Holes per Lateral	Hole Diameter
—	—	—
3 ft	15 holes	¼ inch

Step 4

Determine lateral diameter. Select a lateral diameter that is large enough to keep pressure losses low but small enough to keep costs low. The lateral diameter selection is based on the hole size, hole spacing and lateral length. Graphs, such as the one in Figure 11, have been developed to help in selecting minimum lateral diameters. Select the pipe diameter indicated between the lines on the graph.

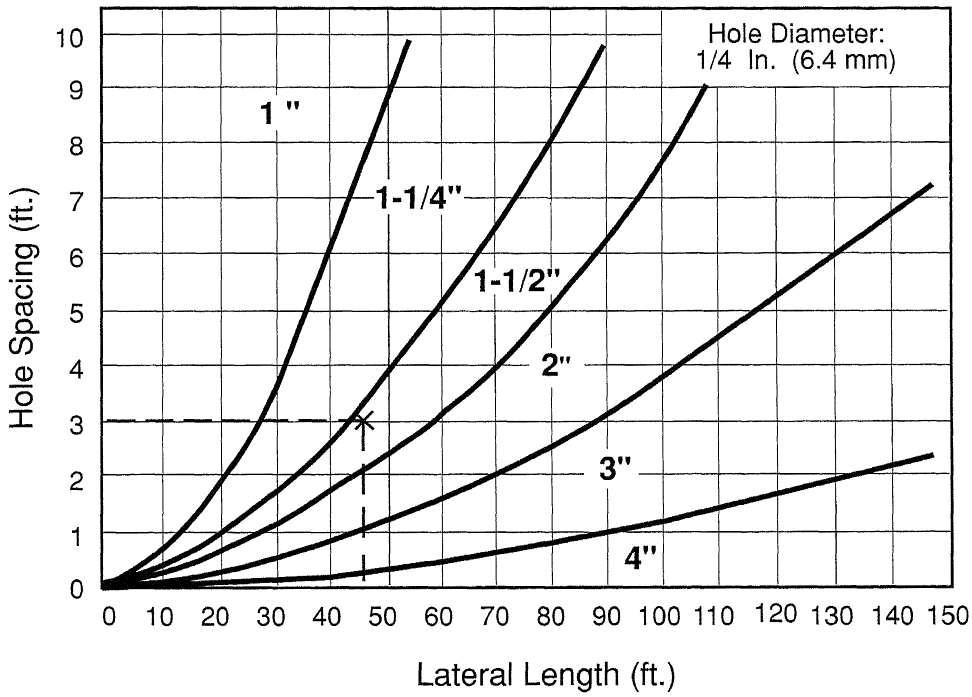


Figure 11. Minimum lateral diameters of plastic pipe for lateral lengths versus spacing for ¼-inch hole diameters. (after: Otis, 1982)

(9)	(10)	(11)	(12)
Lateral Length	Hole Spacing	Hole Diameter	Lateral Diameter
—	—	—	—
45 ft	3 ft	¼ inch	1½ inches

Step 5

Select pressure head to be maintained at the end of each lateral. The head should be between 2 feet and 3 feet. Using the selected head and the hole diameter, the flow rate per hole can be determined from Table 1. By multiplying the flow rate per hole by the number of holes in the lateral, the lateral flow rate can be calculated.

Table 1. Flow rate per hole for ¼-inch holes and various network pressures. (after: Otis, Converse, Carlile, and Witty. 1978)

Head (feet)	Pressure (psi)	Gallons per minute (gpm)
1	0.434	0.74
2	0.867	1.04
3	1.301	1.28
4	1.734	1.47
5	2.168	1.65
6	2.601	1.80
7	3.035	1.95

flowrate per lateral = flowrate per hole x number of holes per lateral

= 1.04 gpm/hole x 15 holes

= 15.6 gpm

(13)	(14)	(15)	(16)	(17)
Hole Diameter	Head at end of Lateral	Flow Rate per Hole	Number of Holes per Lateral	Flow Rate per Lateral
—	—	—	—	—
¼ inch	2 ft	1.04 gpm	15	15.6 gpm

Manifold and Main

The manifold and main pipes connect the mound to the dosing tank. The manifold connects the laterals and distributes the septic tank effluent to each lateral. The main delivers the septic tank effluent from the dosing tank to the manifold. Manifolds and mains are usually PVC pipe with appropriate ell or tee fittings.

The connections between the manifold and the laterals, and the manifold and the main, affect the design of the system. Connections can be made at the center of the pipes or the ends (Figure 8). In addition, the relative elevations of the connections determine how the system drains. Figure 12 illustrates two types of manifold to lateral configurations. If the manifold and laterals are connected at the same elevation with staggered tees as shown in Figure 12 (a), the manifold volume will drain through the holes. If the manifold and laterals are connected at different elevations using tee-to-tee connections, as shown in Figure 12 (b), the manifold volume is part of the delivery pipe system because it drains back to the dosing tank.

The main should be sloped back to the dosing tank so that it drains back to the tank between doses as shown in Figure 13. This prevents freezing in cold weather.

The manifold should be the same diameter as the main or larger. The size and position of the manifold and main are determined for each pressure distribution system. The sizing of the manifold and main is presented in steps 6 through 8, along with an example.

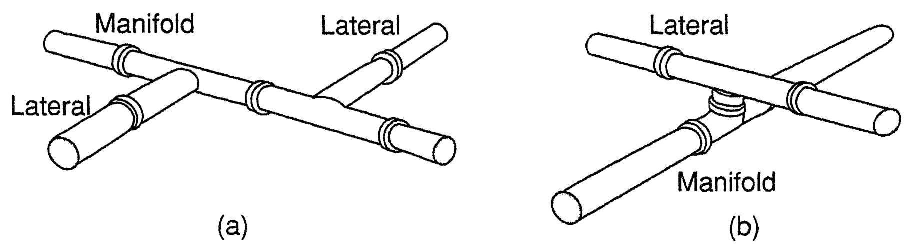


Figure 12. Examples of manifold to lateral connections: (a) staggered tee and (b) tee-to-tee connections.

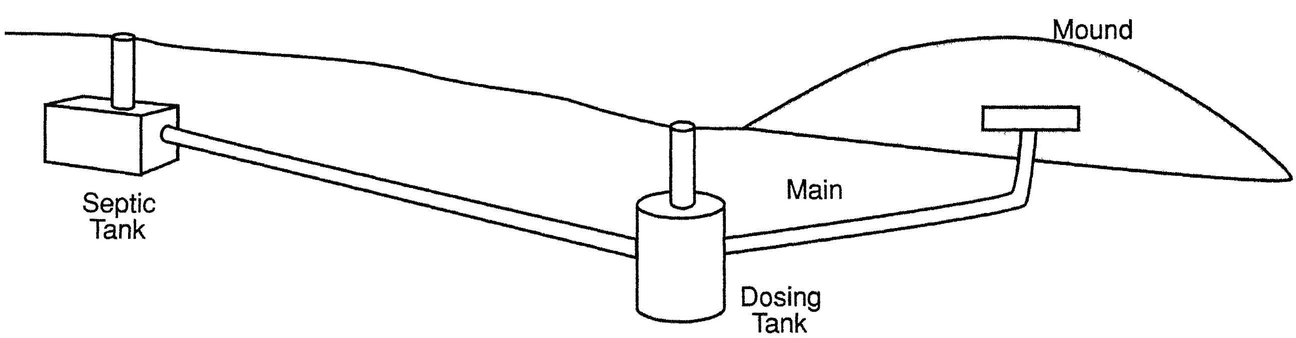


Figure 13. Position of dosing tank relative to the septic tank and mound.

Step 6

Determine the main connection to the manifold: center or end (Figure 14). The point of the main/manifold connection determines the length of the manifold. The manifold length is measured from the main/manifold connection to the end of the manifold.

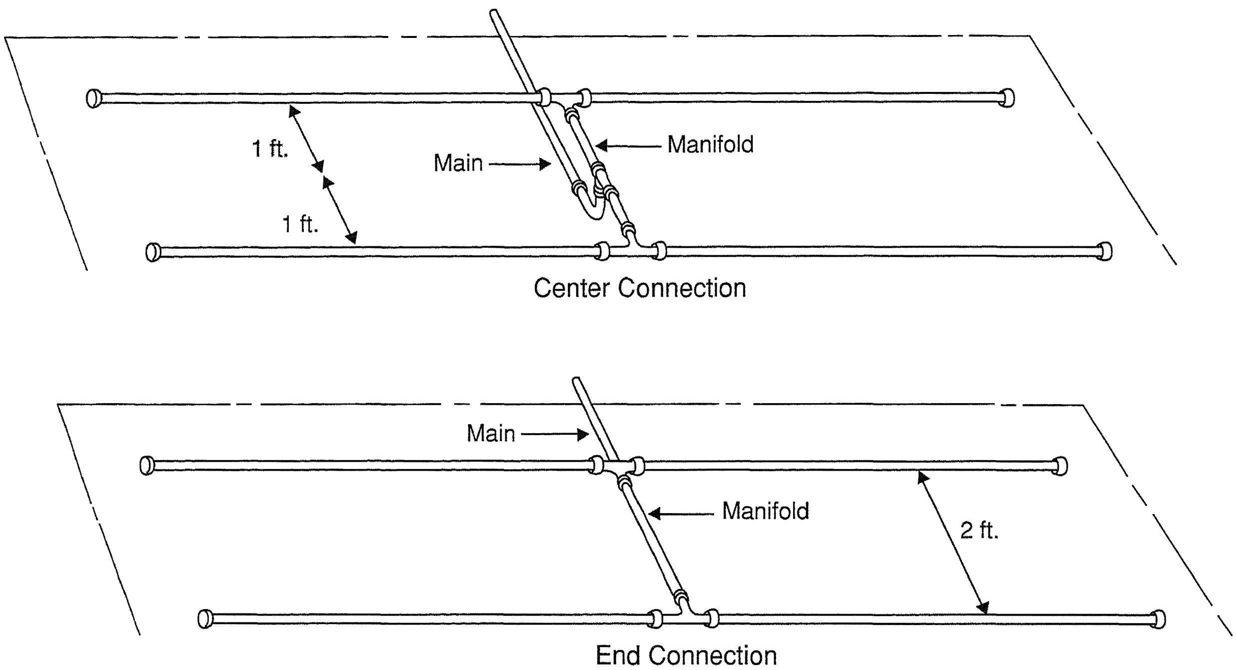


Figure 14. Main connections to manifold in distribution system.

(18)	(19)
Main Connection	Manifold Length
—	—
Center	1 ft

Step 7

From the lateral flow rate, manifold length and lateral spacing, the minimum manifold diameter can be determined from Table 2 for a center manifold and Table 3 for an end manifold connection. If the desired manifold length or spacing is not listed, use the next greater length listed.

Table 2. ***For Center Manifold Connection,*** *the minimum manifold diameter (inches) for various manifold lengths, lateral spacings and lateral flow rates. (adapted from: Clemons. 1991)*

	Manifold Length (feet)											
	2	4		6			8			10		
	Lateral Spacing (feet)											
Lateral Flow Rate (gpm)	2	2	4	2	3	6	2	4	8	2	5	10
5	1¼	1¼	1¼	1½	1½	1¼	1½	1½	1¼	1½	1½	1¼
10	1¼	1½	1¼	2	1½	1¼	3	2	1½	3	2	1½
15	1½	2	1½	3	2	1½	3	2	2	3	3	2
20	2	2	2	3	3	2	3	2	2	3	3	2
25	2	3	2	3	3	2	3	2	2	4	4	3
30	2	3	2	3	3	3	4	2	3	4	4	3
35	2	3	2	3	3	3	4	2	3	4	4	3
40	2	3	3	3	3	3	4	2	3	4	4	3
45	2	3	3	4	4	3	4	2	3	6	4	3
50	2	3	3	4	4	3	4	3	3	6	4	3

The manifold length of 1 ft. is not listed in Table 2.
Use the next greater length, which is 2 ft.

(19)	(20)	(21)	(22)	(23)
Manifold Length	Lateral Spacing	Manifold Position	Lateral Flow Rate	Minimum Manifold Diameter
—	—	—	—	—
1 ft	2 ft	Center	15.6 gpm	at least 1½ inches

Table 3. ***For End Manifold Connection,*** *the minimum manifold diameter (inches) for various manifold lengths, lateral spacings and lateral flow rates. (adapted from: Clemons. 1991)*

Manifold Length (feet)	2	4		6			8			10		
Lateral Spacing (feet) / **Lateral Flow Rate (gpm)**	2	2	4	2	3	6	2	4	8	2	5	10
10	1¼	1¼	1¼	1½	1½	1¼	1½	1½	1¼	1½	1½	1¼
20	1¼	1½	1¼	2	1½	1¼	3	2	1½	3	2	1½
30	1½	2	1½	3	2	1½	3	2	2	3	3	2
40	2	2	2	3	3	2	3	2	2	3	3	2
50	2	3	2	3	3	2	3	2	2	4	4	3
60	2	3	2	3	3	3	4	2	3	4	4	3
70	2	3	2	3	3	3	4	2	3	4	4	3
80	2	3	3	3	3	3	4	2	3	4	4	3
90	2	3	3	4	4	3	4	2	3	6	4	3
100	2	3	3	4	4	3	4	3	3	6	4	3

Step 8

The main diameter is dependent on the system flow rate. From the head loss values given in Table 4, select a pipe diameter that will have a low head loss at the given flow rate. Note that the head losses listed in Table 4 are for a 100 foot piece of pipe. After the main diameter is selected, check the diameter of the manifold. If the manifold is smaller than the main, increase the manifold diameter to match the main.

Table 4. Head loss in schedule 40 plastic pipe. (after: Otis, et al. 1978)

Flow	Pipe Diameter (inches)						
	1	1¼	1½	2	3	4	6
gpm				ft/100 ft			
1	0.07						
2	0.28	0.07					
3	0.60	0.16	0.07				
4	1.01	0.25	0.12				
5	1.52	0.39	0.18				
6	2.14	0.55	0.25	0.07			
7	2.89	0.76	0.36	0.10			
8	3.63	0.97	0.46	0.14			
9	4.57	1.21	0.58	0.17			
10	5.50	1.46	0.70	0.21			
11		1.77	0.84	0.25			
12		2.09	1.01	0.30			
13		2.42	1.17	0.35			
14		2.74	1.33	0.39			
15		3.06	1.45	0.44	0.07		
16		3.49	1.65	0.50	0.08		
17		3.93	1.86	0.56	0.09		
18		4.37	2.07	0.62	0.10		
19		4.81	2.28	0.68	0.11		
20		5.23	2.46	0.74	0.12		
25			3.75	1.10	0.16		
30			5.22	1.54	0.23		
35				2.05	0.30	0.07	
40				2.62	0.39	0.09	
45				3.27	0.48	0.12	
50				3.98	0.58	0.16	
60					0.81	0.21	
70					1.08	0.28	
80					1.38	0.37	
90					1.73	0.46	
100					2.09	0.55	0.07
125						0.85	0.12
150						1.17	0.16
175						1.56	0.21
200							0.28
250							0.41
300							0.58
350							0.78
400							0.99

flow rate per lateral × number of laterals = system flow rate

= 15.6 gpm/lateral x 4 laterals

= 62.4 gpm

main diameter with minimum head loss = 4 inches

increase manifold diameter to match main diameter = 4 inches

(24)	(25)	(26)	(27)	(28)
Flow Rate per Lateral	Number of Laterals	System Flow Rate	Selected Main Diameter	Selected Manifold Diameter
—	—	—	—	—
15.6 gpm	4	62.4 gpm	4 inches	4 inches

Dosing Tank

The dosing tank is a tank placed between the septic tank and the lateral system to accumulate septic tank effluent (Figure 1). Once the accumulated effluent reaches a predetermined volume, the effluent is pumped to the laterals in the mound. Proper dosing tank construction, placement and sizing must be considered to ensure reliable system operation.

The dosing tank construction requirements are the same as for septic tanks. The tank must be durable and watertight and must withstand the soil loads, which tend to push in on the walls. The environment in the tanks is very corrosive, so no metal parts or fittings should be used. The major difference between a septic tank and a dosing tank is that the dosing tank will be emptied on a daily basis. Since the tank will be emptied every day, anchoring it against flotation is critical in areas with a high seasonal or permanant water table, which is where mound systems are often used.

Ensuring that the dosing tank is watertight is also critical. In areas with a high seasonal or permanent water table, groundwater may leak into the dosing tank and overload the mound system. The seals around the pipes that enter and exit the dosing tank are especially vulnerable to leaks. If the pump is running more than the few minutes a day it takes to pump out the accumulated septic tank effluent, groundwater may be leaking into the septic tank or dosing tank.

Dosing tanks can be round or rectangular as shown in Figure 15. A riser to the ground surface is needed for access to the pump. **Never enter a dosing tank.** Any work to replace pumps, switches or connections should be made from the outside. The sewage gases produced in the tank can kill a person in a matter of minutes. When working on a tank, make sure the area is well-ventilated and someone is standing by. **Never go into a dosing tank to retrieve someone who accidentally fell in** without a self-contained breathing apparatus. While waiting for help, the best thing to do is to put a fan at the top of the tank to blow in fresh air.

The pump in a dosing tank should be set a few inches off the tank bottom to provide storage space for solids that may have carried over from the septic tank, as shown in Figure 16. A 6-inch concrete block makes a good pedestal for the pump. Whenever the septic tank is pumped to remove solids, the dosing tank should also be pumped.

The minimum size of the dosing tank is the sum of the dose volume, the volume of the delivery pipe, solids storage volume, and emergency storage volume in case of pump failure. A minimum of one-day emergency storage should be provided. Minimum dosing tank sizes are listed in Table 5.

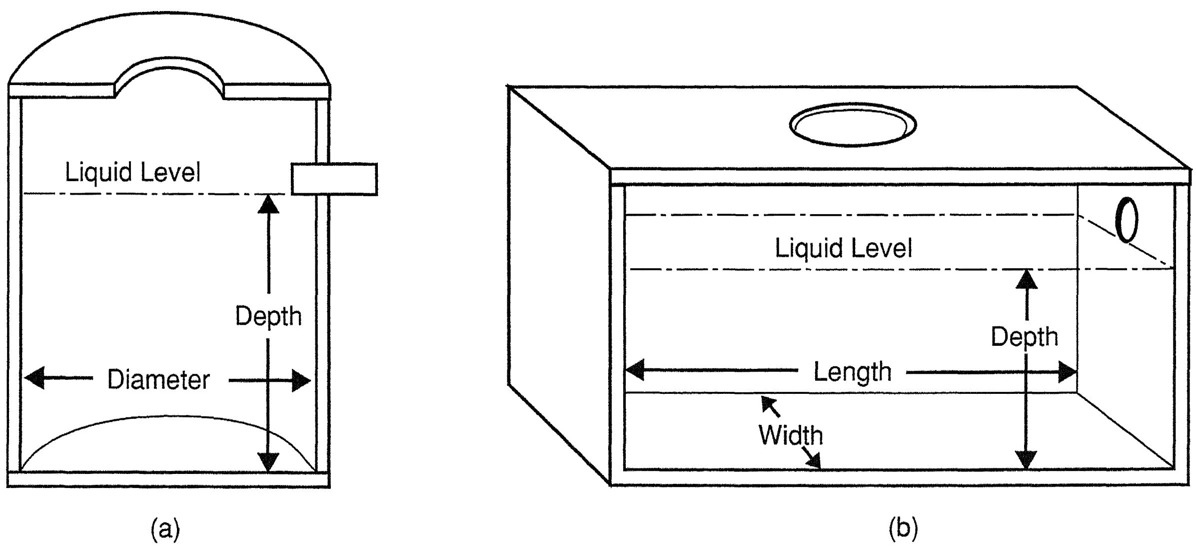
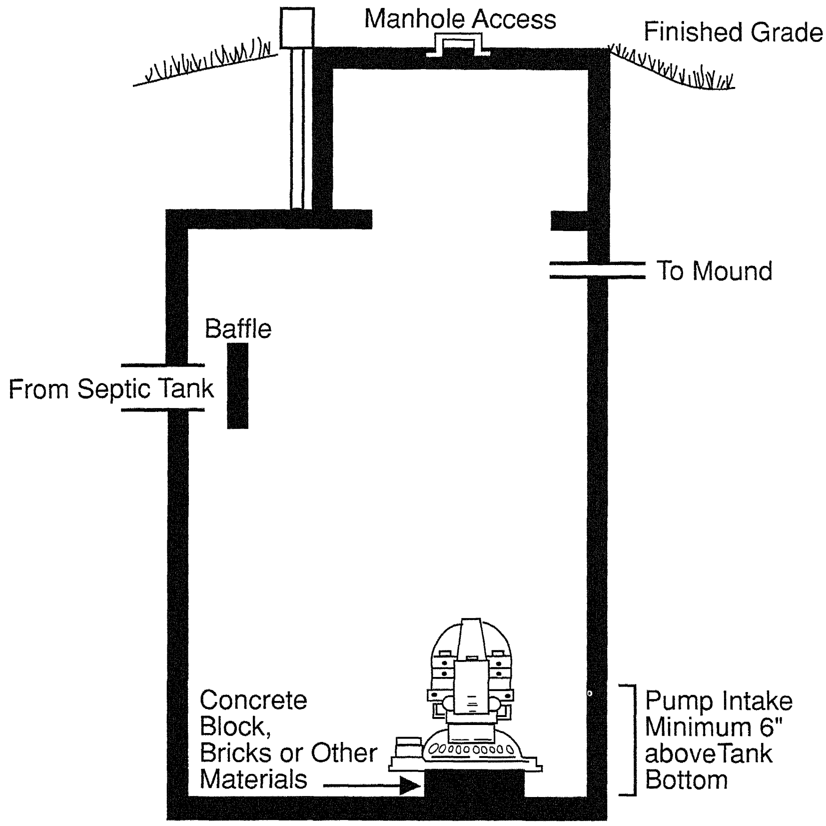


Figure 15. Styles of dosing tank: (a) round, (b) rectangular.



'igure 16. Cross section of dosing tank showing riser and pedestal for pump.

Table 5. Minimum dosing tank size for different sized homes. (after: Converse. 1978)

Home Size No. Bedrooms	Minimum Dosing Tank Size Gallons
1	250
2	250
3	500
4	500
5	750

Pump

In mound systems, the pump delivers septic tank effluent to the mound situated at a higher elevation. The pump also pressurizes the lateral system to provide uniform distribution in the dosing application.

Pumps appropriate for septic tank effluent, called effluent pumps, are designed to operate in the corrosive environment of a sewage system. Effluent pumps can also handle a small amount of solid material without damage.

The pump size is selected based on the system flow rate in gallons per minute (GPM) and the total dynamic head (TDH). The total dynamic head is determined by adding together:

- the elevation difference between the pump outlet and the laterals;
- the head losses in the pipe and fittings; and
- the desired head at the end of the laterals times 1.3 for network losses.

Follow steps 9 through 14 to determine the pump size; they are presented here along with an example.

Step 9

The needed pump capacity in gallons per minute is the system flow rate (determined when sizing the main). The system flow rate is the sum of the flows out of all the holes in the laterals

(29)
System Flow Rate
—
62.4 gpm

Step 10

Establish the relative positions of the mound and the dosing tank, both vertically and horizontally, as shown in Figure 17. Determine the elevation difference between the pump outlet and the laterals. This is called the static lift.

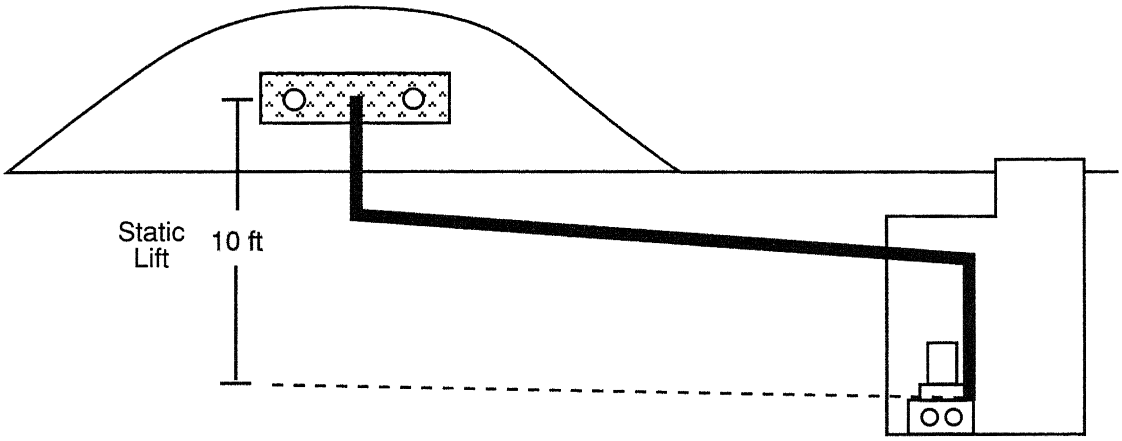


Figure 17. Elevation difference from dosing tank to mound.

(30)
Static Lift
—
10 ft

Step 11

Calculate the head losses in the main pipe and fittings. Determine the total length of main pipe and the types and number of fittings, as illustrated in Figure 18. Add to the length of the main the equivalent lengths of pipe for each fitting, as presented in Table 6 . Multiply the equivalent length of pipe by the head loss per 100 feet of pipe from Table 4. Then divide by 100 to get the head loss in the main pipe and fittings.

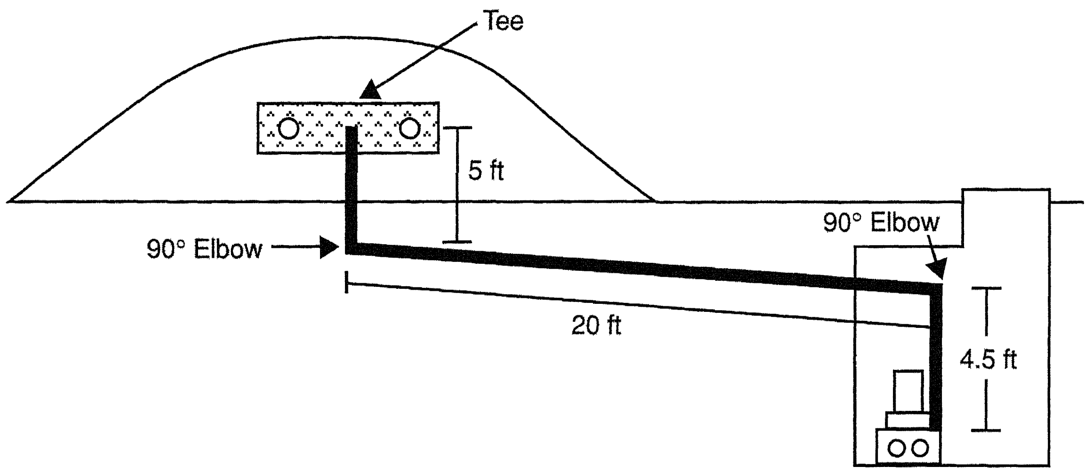


Figure 18. Main length and fittings from dosing tank to mound

main pipe length = 20 ft + 5 ft + 4.5 ft = 29.5 ft

equivalent length of pipe for 2–90° elbows = 2 elbows x 14 ft/elbow = 28 ft

equivalent length of pipe for tee = 22 feet

total equivalent length of pipe = 29.5 ft + 28 ft + 22 ft = 79.5 ft

head loss in 100 ft of 4-inch pipe at 62.4 gpm = 0.22 ft (from Table 4, page15)

head loss in 79.5 ft of 4-inch pipe = $\frac{0.22 \text{ ft} \times 79.5 \text{ ft}}{100 \text{ ft}}$ = 0.17 ft

(31)
Main Head Loss
—
0.17 ft

Table 6. Head losses through plastic fittings in terms of equivalent lengths of plastic pipe. (after: Clemons. 1991)

Type of Fitting	Nominal Size Fittings and Pipe — Inches					
	1¼	1½	2	2½	3	4
	Equivalent Lengths of Pipe — Feet					
90° Std. Elbow	7.0	8.0	9.0	10.0	12.0	14.0
45° Std. Elbow	3.0	3.0	4.0	4.0	6.0	8.0
Std. Tee	7.0	9.0	11.0	14.0	17.0	22.0
Check Valve	11.0	13.0	17.0	21.0	26.0	33.0
Coupling or Quick Disconnect	1.0	1.0	2.0	3.0	4.0	5.0
Gate Valve	0.9	1.1	1.4	1.7	2.0	2.3

Step 12

Determine the network losses by multiplying the desired head at the end of the laterals (from step 5) by 1.3

head at end of laterals x 1.3 = 2 ft x 1.3 = 2.6 ft

(32)
Network Loss
—
2.6 ft

Step 13

Determine total dynamic head (TDH) by adding together the elevation difference (from step 10), the head loss in the main pipe and fittings (from step 11), and the network head losses (from step 12).

static lift = 10 ft

main pipe loss = 0.17 ft

network loss = 2.6 ft

total dynamic head = 10 ft + 0.17 ft + 2.6 ft = 12.77 ft

(30)	(31)	(32)	(33)
Static Lift	Main Head Loss	Network Loss	Total Dynamic Head
—	—	—	—
10 ft	0.17 ft	2.6 ft	12.77

Step 14

Examine pump curves to help select an appropriate pump. Two examples of pump curves are presented in Figure 19. Each pump will have a rating curve, which compares pump capacity (in GPM) to the head (in feet) it will provide. Select a pump that will provide sufficient head for the capacity needed. Avoid selecting too large a pump, with the GPM versus TDH far below the curve. Large pumps are more expensive. The required TDH for the GPM should be on or just below the pump curve, within the middle two-thirds of the curve, for most efficient operation.

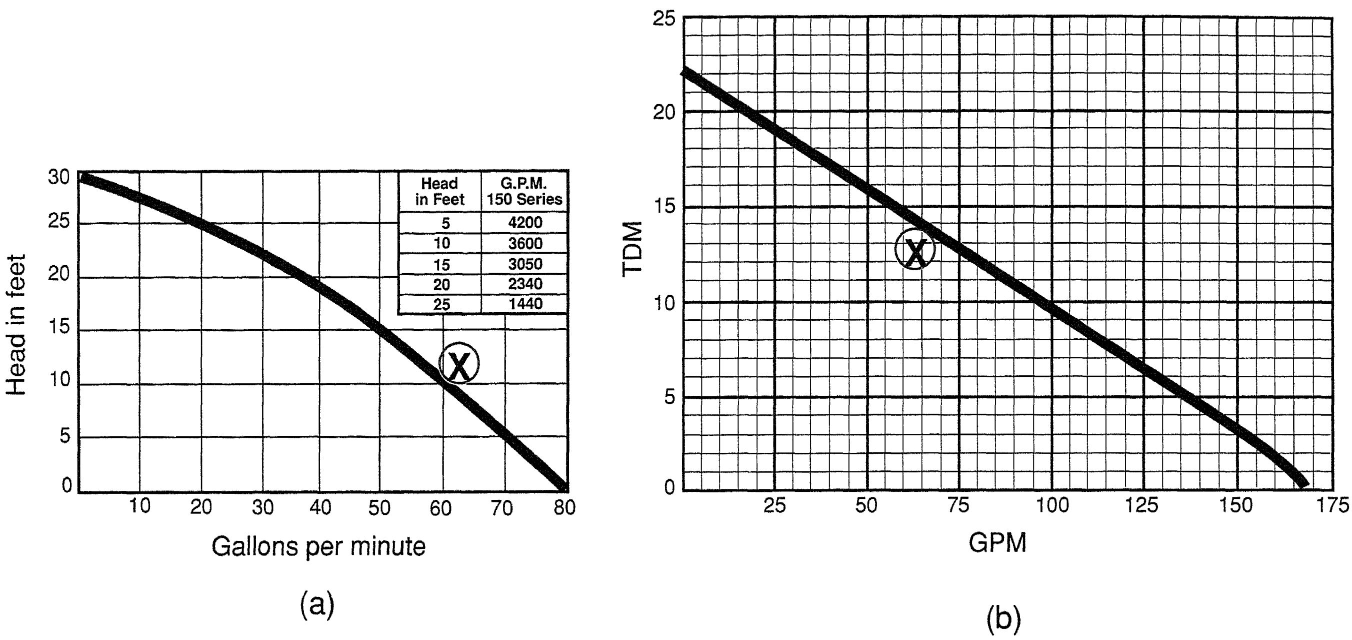


Figure 19. Example pump curves for two different pumps

For this example:

Pump (a) is undersized, while Pump (b) is large enough to provide sufficient head at the necessary flow rate. Select Pump (b).

Controls and Power Supply

The purpose of the dosing system is to pump a predetermined volume of septic tank effluent from the dosing tank to the mound. The pump must be turned on when enough septic tank effluent collects in the dosing tank, and shut off when the effluent remaining in the tank reaches the solids storage level. The pump is usually controlled by float switches suspended in the tank, as shown in Figure 20. A third switch is used to trigger an alarm when the effluent collected in the dosing tank reaches twice the dose amount (emergency level).

The settings for the switches are determined based on the dose volume and the size and geometry of the tank. The dose volume is the volume of the delivery pipes plus 5 times the volume that will drain through the holes plus the volume of the delivery pipes. The procedure for setting the levels for the controls is presented in steps 15 through 17, along with an example.

Step 15

Determine volume of pipe that will drain through the holes and the volume of the delivery pipes that will drain back into the dose tank. Remember, this is determined by the style of manifold/lateral connections (Figure 12). In staggered tee connections, the manifold drains through the holes. In tee-to-tee connections, the manifold drains back to the dosing tank. Table 7 lists the pipe volume per foot of pipe for several diameters of pipe.

Table 7. Pipe volumes in gallons per foot of pipe. (after: Clemons. 1991)

Pipe Size (inches)	Volume in Gallons per Foot of Pipe
1¼	0.07
1½	0.10
2	0.17
2½	0.24
3	0.38
4	0.65

For staggered tee connection, the lateral and manifold volume drains through the holes.

volume that
drains through holes = [total lateral length (feet) x 0.17 gal/ft] + [manifold length (feet) x 0.65 gal/ft]
= [180 ft x 0.17 gal/ft] + [2 ft x 0.65 gal/ft]
= 31.9 gal

(34)	(35)	(36)	(37)	(38)
Lateral Diameter	Gallons per Foot	Total Lateral Length	Total Lateral Volume	Manifold Diameter
—	—	—	—	—
2 inches	0.17	180 ft	30.6 gal	4 inches

(9)	(40)	(41)	(42)
Manifold Length	Gallons per Foot	Manifold Volume	Volume that Drains Through Holes
—	—	—	—
2 ft	0.65	1.3 gal	31.9 gal

Step 16

Determine dose volume. Dose volume is 5 times the volume that will drain through the holes plus the volume of the delivery pipes. Check valves are sometimes used on very long main pipes to eliminate the need to drain and refill them. However, main lines with check valves must be protected from freezing.

volume that drains back to dosing tank = main length (ft) x 0.65 gal/ft = 29.5 ft x 0.65 gal/ft
=19.2 gal

dose volume = [volume that drains through holes(gal) x 5) + [volume that drains back to dosing tank(gal)]
= [31.9 gal x 5] + 19.2 gal = 179 gal

(42) Volume that Drains Through Holes	(43) 5 times Volume that Drains Through Holes	(44) Main Length	(45) Gallons per Foot	(46) Main Volume	(47) Dose Volume
—	—	—	—	—	—
31.9 gal	159.5 gal	29.5 ft	0.65	19.2 gal	179 gal

Step 17

Set the control switches. Mercury level controls are recommended in dosing tanks. They are simple, reliable switches that can turn the pump on and off. One switch is needed to turn the pump on and a second switch is placed below it to turn the pump off (Figure 20). A third switch is used to activate an alarm if the effluent level exceeds two days storage. The distance between 2 adjacent switches is the dose volume. The distance needed between two switches depends on the size and shape of the dose tank. The gallons per inch in a circular tank (Figure 15(a)) can be determined by:

$$\frac{\pi}{4}(\text{Diameter (inches)})^2 \times \frac{1\text{gal}}{231\ \text{in}^3} = \frac{\text{Diameter (inches)} \times \text{Diameter (inches)}}{294} = \text{gallons per inch of depth}$$

The gallons per inch a rectangular tank [Figure 15(b)] can be determined by:

$$\text{Width (inches)} \times \text{Length (inches)} \times \frac{1\ \text{gal}}{231\ \text{in}^3}$$

= gallons per inch of depth

$(72 \times 72) \div 294 = 17.7$ gal/inch

dose vol ÷ gal per inch = switch separation

179 gal ÷ 17.7 gal/inch = 10 inches

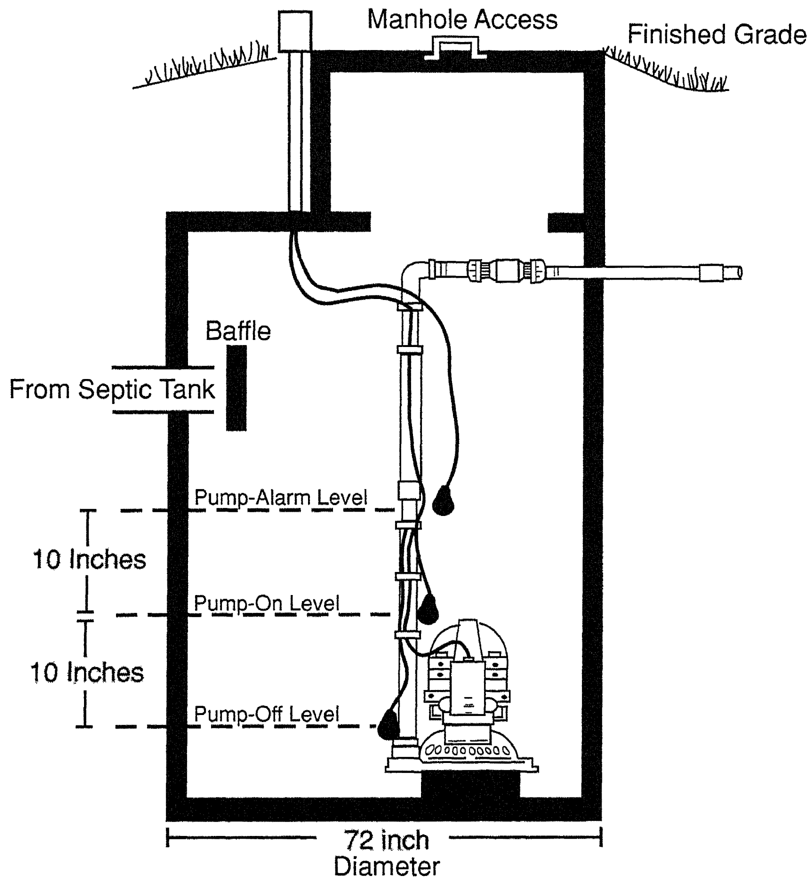


Figure 20. Mercury level controls used in dosing tank.

(48)	(49)	(50)	(51)	(52)
Tank Shape	Tank Diameter	Gallons per inch	Dose Volume	Switch Separation
—	—	—	—	—
Circular	72 inches	17.7 gal	179 gal	10 inches

Electrical Power Supply and Controls

All wastewater distribution systems that utilize a pump require electrical power and control systems. Proper wiring materials and installation procedures are critical to the safety of the installer, sewage system user and all individuals involved in future repairs and maintenance. Adequate wiring ensures reliable pump and system performance. Follow a few basic guidelines to ensure safe and reliable operation at a reasonable cost. In all cases, installation procedures must follow the specifications of the National Electric Code or any other prevailing code. Contact local electrical inspection authorities for permits and inspection requirements. Work should be done by a qualified electrical installer.

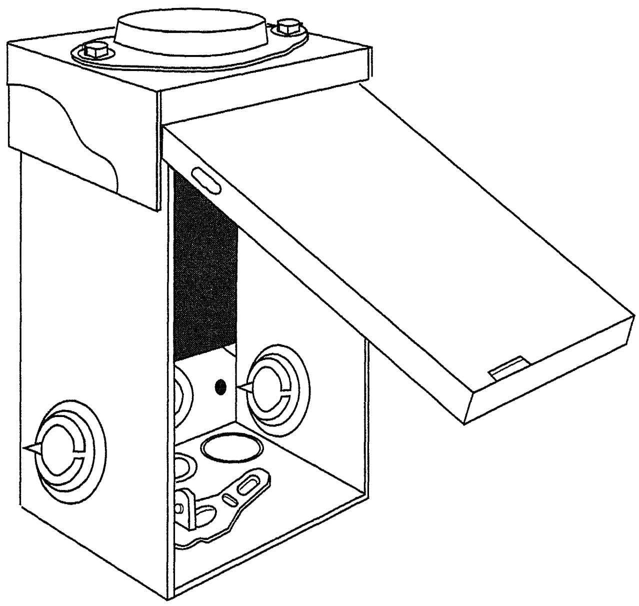


Figure 21. Weatherproof box (Driptight) for outdoor wiring.

Types of Materials for Outdoor Wiring

Electrically, there is no difference between wiring inside or outside a building. However, the materials and installation procedures are considerably different. Outdoor wiring must be able to withstand exposure to water, weather and corrosive environments. This is certainly the case for wiring septic system dosing chambers. While there are several types of systems for outdoor and underground wiring based on what materials are used, each has specific applications.

Boxes and Panels

Outdoor equipment used in residential wiring must be weatherproof. The two most common types of weatherproof equipment are driptight and watertight. Driptight equipment seals against water falling vertically. Driptight boxes are usually used for control or circuit breaker panels. Watertight boxes seal against water coming from any direction. Individual junction boxes, switch boxes and receptacle boxes will usually be of the watertight type.

Driptight boxes are usually made of painted sheet metal and have shrouds or shields that deflect rain falling from above. An example of a driptight unit is shown in Figure 21. These boxes are not waterproof and should not be used where water can spray or splash on the unit.

Watertight boxes are designed to withstand temporary immersion or spray streams from any direction. They are commonly made of cast aluminum, zinc-dipped iron, bronze or heavy plastic and have threaded entries for watertight fittings and gasketed covers. Figure 22 shows a watertight switch box and receptacle.

Wiring Materials

Two methods, or a combination of the two, are common in outdoor wiring. One method is to place electrical wires inside a conduit. The other is to use cable. In either case, protection from physical damage, water and corrosion must be provided. Both approaches are illustrated in Figure 23.

Running wires through sealed conduit provides physical, water and corrosion protection. Several kinds of conduit are acceptable for outdoor use. Rigid metal conduit made from aluminum or steel provides equivalent wire protection. However, aluminum conduit is not recommended for installation where it is directly in contact with soil. Rigid PVC conduit made from polyvinyl chloride can be used above ground. High-density polyethylene conduit is suitable for underground installation. Do not use thinwall conduit (EMT) for underground or outdoor installations.

An underground feeder (UF) cable (Figure 24) can be buried without conduit protection. Physical protection for underground cable is

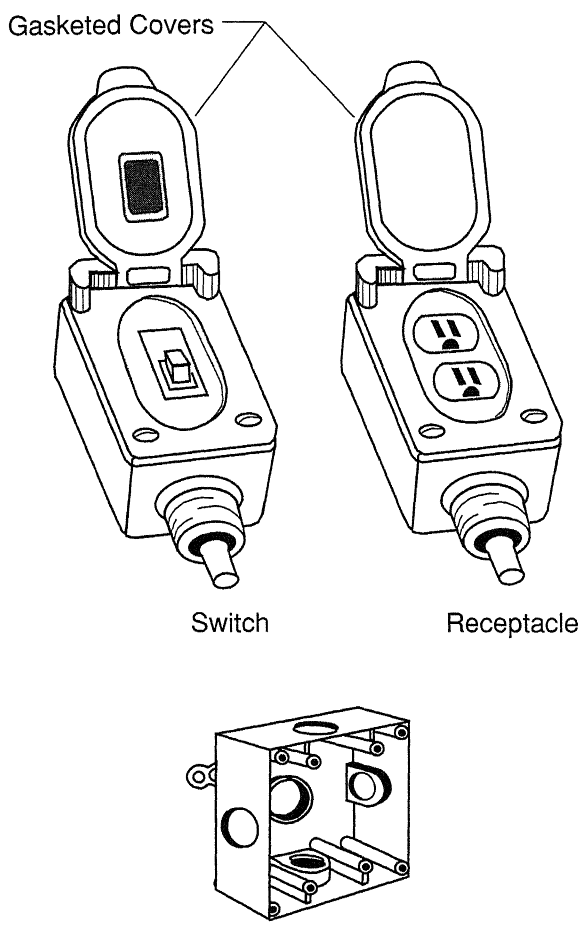


Figure 22. Weatherproof boxes (Weathertight) for wet locations.

highly recommended to reduce the risk of spading through the cable at a later time. A redwood board buried just above the cable is highly recommended to provide physical protection. Do not use nonmetallic (NM) cable (Figure 24) for underground installations. While it is an excellent material for interior wiring, it will not withstand the moisture conditions in the soil.

Combining the conduit and cable wiring methods is also an option. Conduit can be used around cable for physical protection. Conduit is particularly useful to protect cables where they enter and exit the soil. If conduit and cable are used in combination, as shown in Figure 23, appropriate connectors and bushings are needed for transitions from one system to the other. Minimum burial requirements apply to wire in conduit and cables. Table 8 lists the National Electric Code requirements for each type of installation.

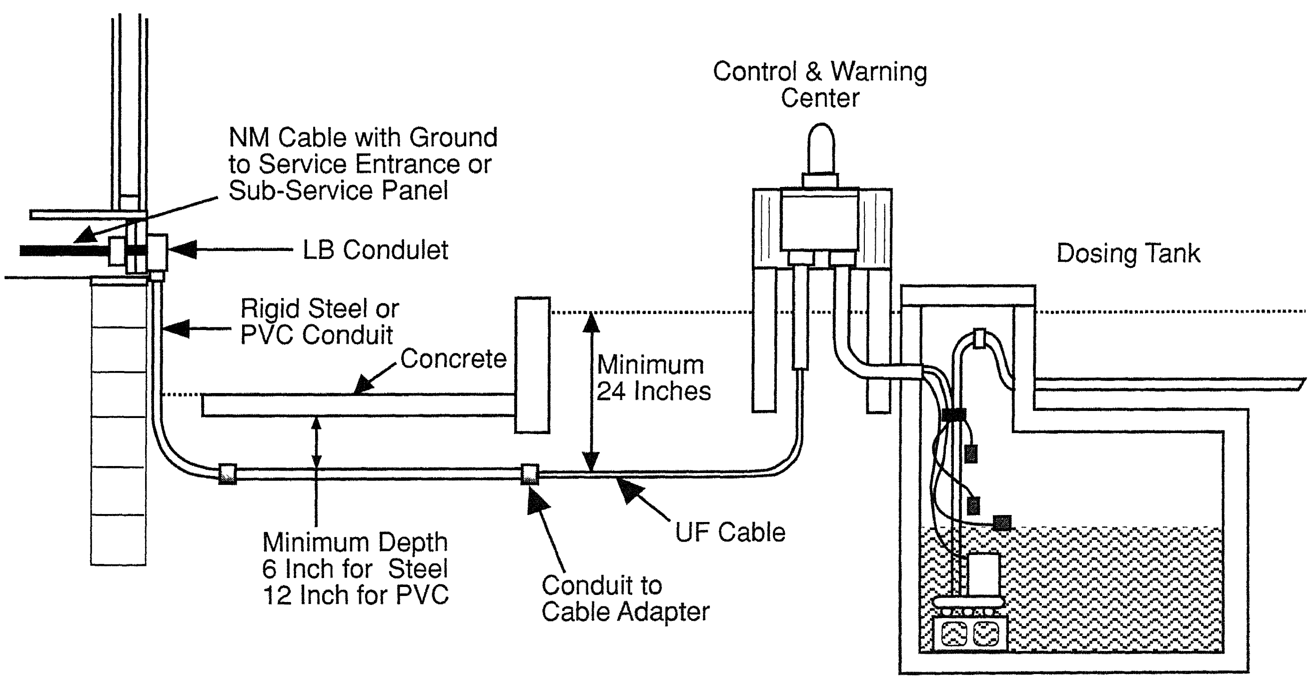


Figure 23. Power and control system for onsite wastewater system.

Control Switches for Pump

Control switches sense the water level in the dosing tank and signal the pump or alarm system. A failure of the control switches can cause sewage to back up into the home or come out the top of the dosing tank. Follow some simple guidelines to avoid control problems.

First, select the appropriate switches. Mercury switches encased in a plastic or neoprene float are recommended. In Figure 25, one switch is used to both start and stop the pump. In Figure 26, one switch is used to start and a different switch is used to stop the pump. In both cases, a separate switch is used to activate the alarm system if the liquid level rises too high in the tank. Some switches handle power to the pump directly, while others require a relay.

Second, make no electrical connections inside the dosing tank. This includes plug-ins, screw-type, twisted wire, boxes, relays or any other type of connection that requires movement to connect or operate. If connections or splices must be made, they should be located in a watertight, corrosion-resistant junction box with watertight, corrosion-resistant fittings and gasketed cover.

An alarm system is used to alert the homeowner to a pump malfunction by means of an audible or visual signal. Therefore, the alarm system must be powered in such a way that if the pump circuit fails the alarm will still operate. Provide a means to turn off the alarm without losing power to the pump.

Pump and Alarm Control Center

The cables that connect to the pump control switch, alarm switch and pump all originate from the pump and alarm control center. The

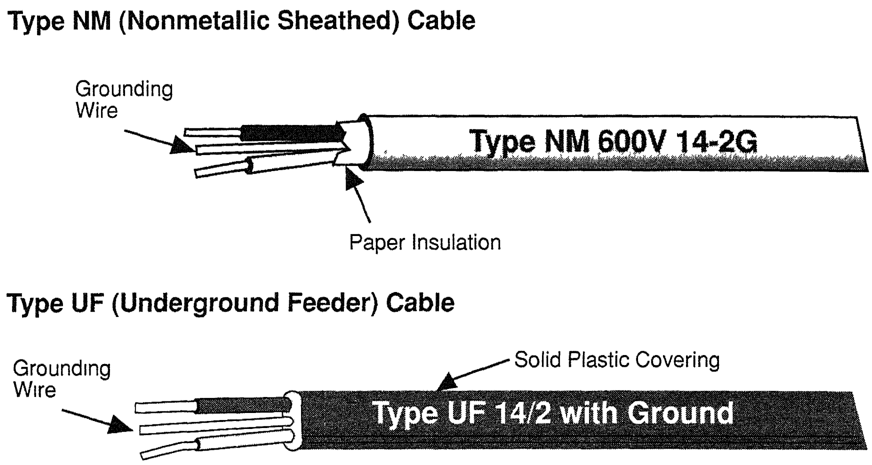


Figure 24. Example electrical cable types.

Table 8. Required burial depths for branch circuits. (after: 1990 National Electric Code. Section 300-5)

	Cable	Rigid Metal Conduit	Rigid Non-Metallic Conduit
Direct in soil	24 in.	6 in.	18 in.
Under concrete	18 in.	6 in.	12 in.

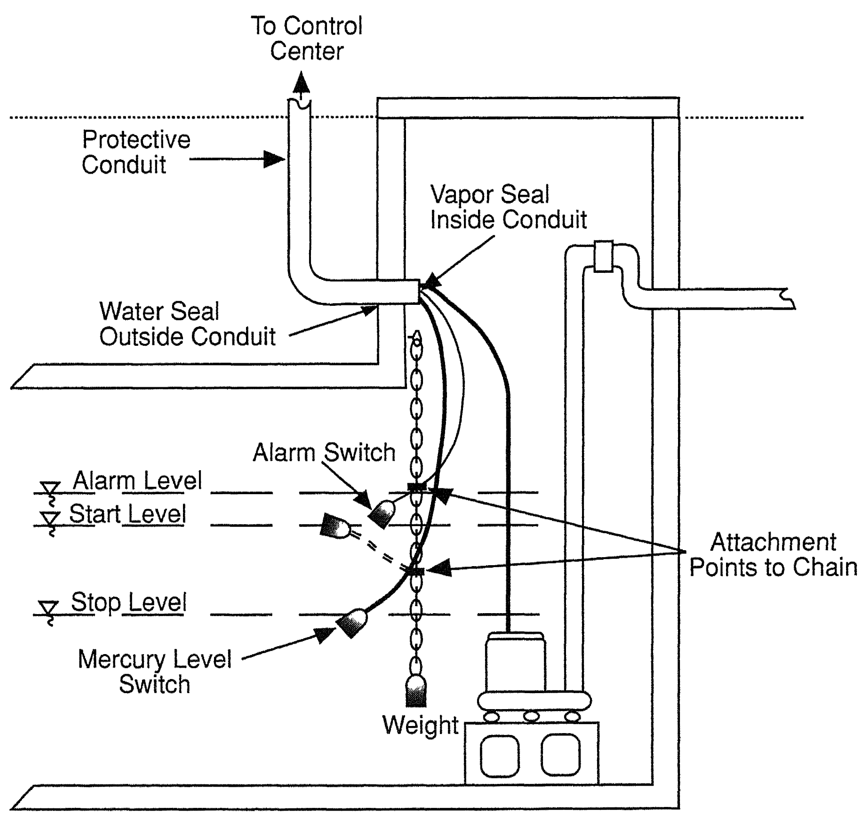


Figure 25. Two-switch control system for dosing tank.

center should either be placed inside a nearby building (such as a basement or garage) or inside a weatherproof box on a post near the entrance port to the dosing tank. Never place the control system inside the dosing tank or access passageway. The moisture in the dosing tank will cause the system to corrode and fail.

The preferred location for the control and alarm center is in a dry area, such as a basement or garage. Conventional indoor wiring material may be used. Order pump and controls with extra-long cables.

When a nearby building is not available, locate the control center in a weatherproof enclosure mounted to a treated wood or steel post near the entrance to the dosing tank. Two typical outdoor pump and alarm control centers are shown in Figures 27 and 28. In both cases, it is important to use wire, connectors and weatherproof enclosures appropriate for outdoor use.

A pump motor relay with built-in motor overcurrent protection is shown in Figure 27. The pump motor start and stop switches control the relay coil current. Conduit is shown for physical protection of the conductors and cables entering and leaving the box.

A pump motor controlled by the mercury switches and relay built into a plug-in type unit is shown in Figure 28. Overcurrent protection for the motor is supplied by the ground-fault circuit interrupter (GFCI), circuit breaker combination in a weatherproof enclosure. National Electric Code requirements state that all outdoor outlets of a residence must be GFCI protected. The GFCI protected receptacle for the pump power and control circuit should be enclosed in a watertight box. Another alternative is to use a receptacle with built-in GFCI protection and a standard circuit breaker. In either configuration, the alarm system is powered from a separate circuit breaker to prevent tripping the alarm circuit when the pump circuit is tripped.

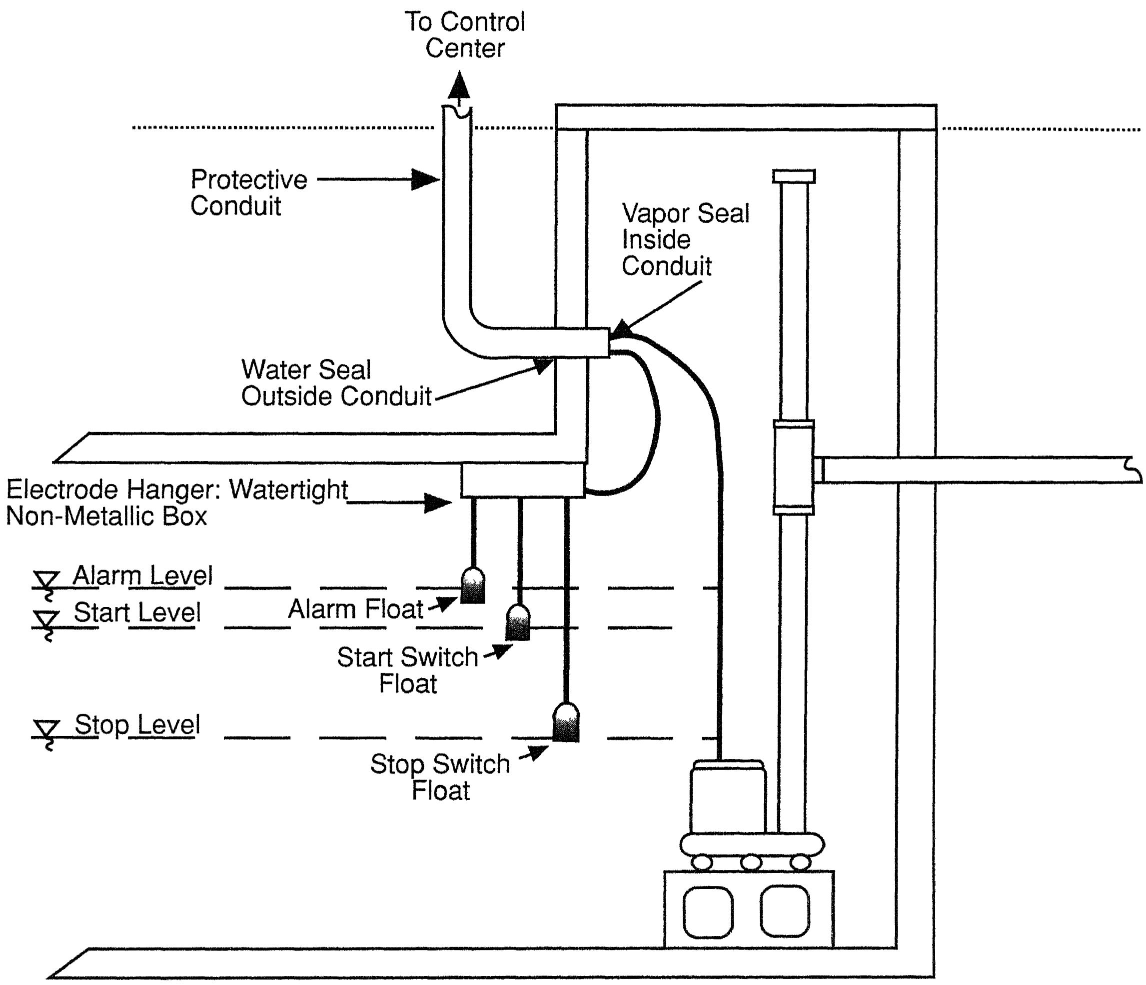


Figure 26. Three-switch control system for dosing tank.

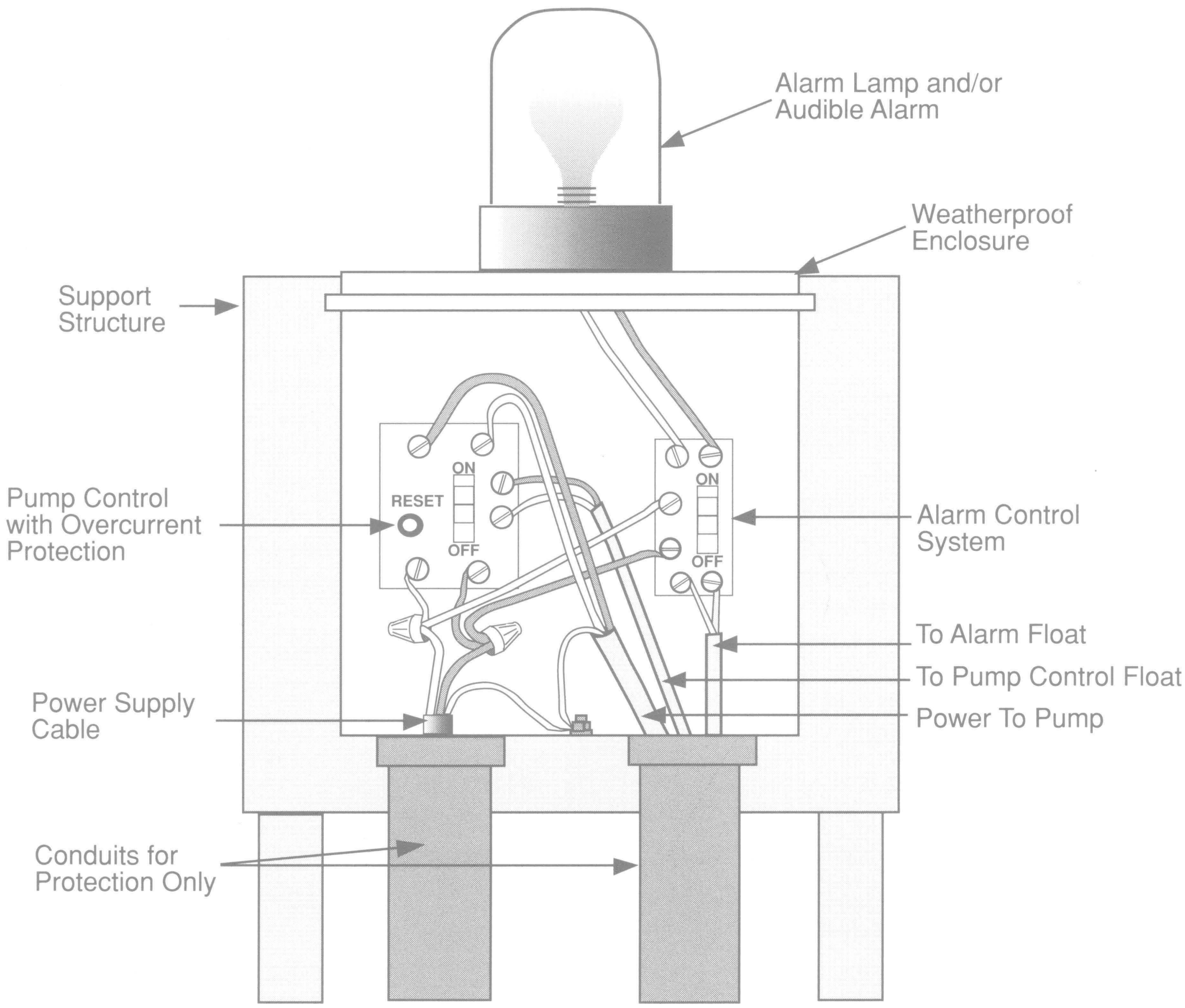


Figure 27. Outdoor control center with built-in pump control.

Wiring from the Pump and Alarm Control Center to the Pump and Switches

The power cable to the pump and float switch cables running from the control center into the tank should be run in conduit (metal or PVC) where physical protection is needed. The area around the conduit entering the tank should be sealed to prevent surface water from entering the tank through the conduit, as shown in Figures 27 and 28. If the conduit provides a continuous connection between the control center box and the tank, the conduit entrance to the box should be plugged with electrical putty to prevent the movement of moisture and corrosive gases into the control box. Power cables used in these installations, such as Type SE, SJ or SOW, must be suitable for moist and corrosive environments. The power cable to the pump must have a grounding conductor (usually a green insulated wire) to ground the pump motor frame. Metallic conduit should not be used for equipment grounding to or within the tank. Since the pump is considered a motor load, it must have appropriate disconnecting means. The disconnect for units of 1 horsepower or greater (circuit breaker or switch) must be clearly marked and in sight of the pump location or lockable. This prevents inadvertent reactivation of the circuit during servicing of the unit. Below 1 hp, receptacles and plugs listed for motor loads (hp listed) may be used.

Power Supply to the Pump and Alarm System Control Center

Power to the pump and alarm system control center, when located outside a building, will most frequently be supplied by an underground branch circuit from a nearby service entrance or sub-panel. Follow electrical code specifications for materials and burial depths as described earlier. Avoid routing buried wiring through existing or anticipated gardens or landscaping areas to minimize the chances of damage due to spading.

Power to the control center should be from a single individual branch circuit with no other loads. The circuit breaker or fuse supplying this circuit should be clearly marked at the service entrance location.

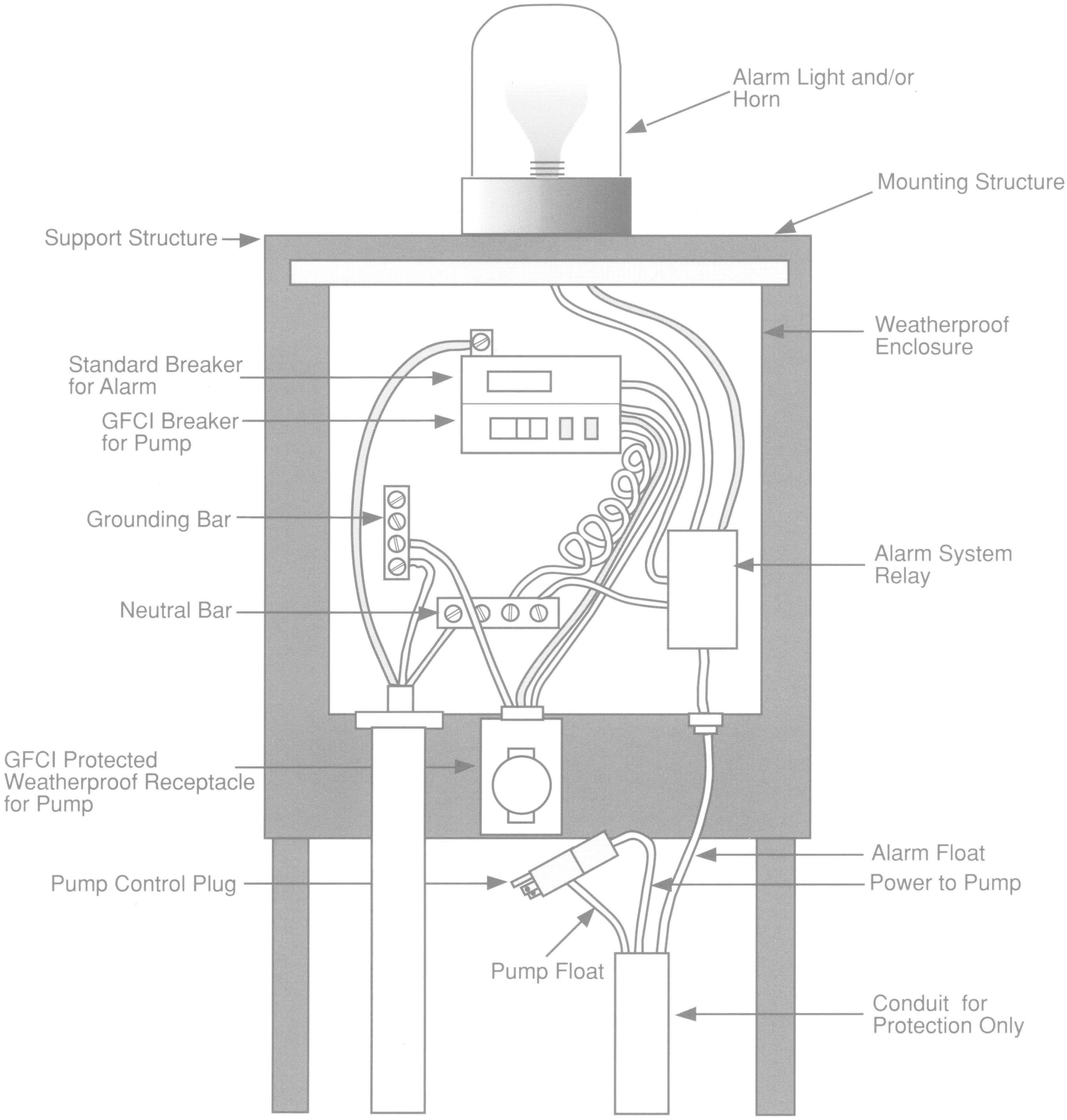


Figure 28. Outdoor control center with external pump control.

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